**Chemistry – EDU 1480Y**

**Questioning Exercise – Bohr diagram of a chlorine atom**

1) Main idea – determining number of electrons from atomic number, properly determining arrangement of electrons in shells, representing this with Bohr diagram

Students should already be familiar with:

- definition of an element, isotope

- three types of subatomic particles (protons, neutrons, electrons)

- using the periodic table of the elements to identify number of protons, electrons in an atom

(meaning of atomic number)

2) Visuals: periodic table, rings to represent electron shells

3) Questions:

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| # | Cognitive Level | Question | Expected Answer |
| 1 | K | What are the three types of particles that exist in an atom, and the charges of each? | Protons (positive), neutrons (zero) and electrons (negative). |
| 2 | K | Find the element chlorine on your periodic table – how can you tell how many protons each chlorine atom contains? | Chlorine has an atomic number of 17, so it has 17 protons. |
| 3 | K | What is the net charge on a neutral atom of chlorine? | A neutral atom has a net charge of zero. |
| 4 | K | So how many electrons must there be in each atom of chlorine? | There must be 17 electrons in an atom of chlorine. |
|  |  | Distribute rings to class, start discussing how electrons travel around the nucleus (in concentric spherical “shells”). Rings are labelled to show that the 1st shell can hold a maximum of 2 electrons, 2nd shell a maximum of 8, 3rd shell a maximum of 8. |  |
| 5 | K | Start simple: How many electrons are there in an atom of hydrogen? (A: 1) How can you tell? (A: from the atomic number of 1, which represents the number of protons and electrons in an atom of H) | One electron, because hydrogen has an atomic number of 1, which represents the number of protons and electrons in an atom of hydrogen. |
|  |  | Have the class put one “electron” in the first shell of their “atom”, with the “nucleus” in the middle. |  |
| 6 | K | How many electrons are there in an atom of helium, and why? (A: 2 electrons because of atomic number, etc.) | Two electrons, because helium has an atomic number of 2, which represents the number of protons and electrons in an atom of helium. |
|  |  | Have the class put the 2nd electron in the 1st shell, which fills it. |  |
|  |  | The next element is lithium, with 3 electrons. Since the first shell can hold only 2 electrons, the next electron goes in the 2nd shell. (Have the class demonstrate this with their rings.) |  |
| 7 | A | What do you think the electron diagram will look like for Beryllium? Show your answer by using your rings. | Expect that the 4th electron will be paired with the 3rd and acknowledge this logical answer. Then, discuss how electrons actually fill a shell, remaining unpaired until after the shell is half full. |
| 8 | A | Based on what we discussed earlier, which element will be the first one with a full 2nd shell? | Neon (atomic number 10, two electrons in 1st shell plus eight in 2nd) |
| 9 | A | What do you think you will need for elements with atomic numbers greater than 10? Why? | A 3rd shell will be needed, because the first two shells together can hold a maximum of 10 electrons. |
| 10 | HOTS | Think about what the diagram will look like for Sodium (atomic no. 11). Are there any similarities to the diagram you drew for Lithium? | There will be an extra (3rd) shell, since the first two shells can hold only 10 electrons. The number of electrons in the outer shell is the same for both. |
| 11 | A | Now think about the diagram for chlorine (atomic no. 17). What will this diagram look like? | Two electrons in 1st shell, full 2nd shell with 8 electrons (in four pairs) and 3rd shell with 7 electrons (three pairs, one alone). |
| 12 | HOTS | In your groups, choose a group of elements that are either in the same row or the same column of the periodic table. Using your rings, figure out what the Bohr diagram will look like for each of the elements you chose and record what they have in common. | Elements in same row have same number of shells; elements in same column have same number of electrons in outer shell. |
| 13 | HOTS | For homework, see if you can think of another way, different from a Bohr diagram, to represent how an atom’s electrons are positioned around its nucleus. | Multiple answers possible. |

**Peer Feedback:**

My partner and I actually chose the same topic, so her feedback was especially insightful. She commented on how I was able to rephrase one or two of my questions to help her understand what I was looking for in response. I know that this skill, asking the same question in a clearer way, is an important one that I will continue to develop with experience. My partner also appreciated my use of simpler examples to begin with was helpful – so students could grasp the idea for the first few elements before moving on to a larger, more complicated situation. She suggested that I ask more probing questions for these earlier examples to ensure that students had fully understood the material from previous lessons (the meaning of an element’s atomic number, and what information it provides regarding numbers of protons and electrons in an atom of that element). And although my partner did not specifically mention it, I know that I did too much of the talking during my lesson, and will need to involve the students more in future lessons.

**Reflection:**

I chose a topic with which I was quite familiar, so I did not have too much difficulty seeing in my mind a sequence of questions that would lead to the desired result. My partner confirmed that the sequencing of my questions was logical and led to a good conclusion. What was challenging was creating open-ended questions for this topic – I found that most of my questions were at the knowledge of application levels. I know that as I become more familiar with the types of higher-level questioning summarized by Bloom’s taxonomy, I will feel more comfortable designing a wider variety of questions that challenge my students to think critically about the content, rather than just memorizing facts and applying them.

In addition to my partner’s comments, I noticed other parts of my lesson that required attention. She used some excellent manipulatives in her lesson, and while she was teaching I was able to see how I could incorporate some as well. I know that my learning style is such that I don’t always see the need for manipulatives. For an abstract concept such as this, my partner modelled for me how effective they can be, so I have devised and included a set of electron “rings” to go along with this lesson.

Another challenge for me was teaching this lesson while seated and to only one “student”. I found that it was difficult for me to be “in the moment”, since the flow of the lesson was different from how it would be with a full class. On more than one occasion, I found myself critiquing in my mind what I had just said/asked, rather than focusing on what was next.

Finally, I know that it is also my tendency to try to squeeze too much into a lesson. So although I had initially prepared a few questions on isotopes (as referenced in Figure 2 on page 25 of the Questioning Module), I decided to eliminate these immediately before teaching to my partner to focus only on Bohr diagrams. I suspect that this is something I will need to continue working on, to present the curriculum in manageable chunks each lesson.